RECLAMATION

Managing Water in the West

Brown-Headed Cowbird Control Program

Results of Follow-up Monitoring—Years 2002-2004

Bill Williams River National Wildlife Refuge and Alamo Lake State Wildlife Area, Arizona

U.S. Department of the Interior
Bureau of Reclamation
Lower Colorado Regional Office
Boulder City, Nevada

Technical Service Center
Ecological Planning and Assessment Group
Denver, Colorado

November 2004

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Bill Williams River
National Wildlife Refuge
and
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Introduction

From 1998 through 2001, the Bureau of Reclamation (Reclamation) implemented a brown-headed cowbird (BHCO) control and trapping program in the Lower Colorado River Region in Arizona. This was done to prevent further declines and promote recovery of breeding populations of the southwestern willow flycatcher (WIFL) and other neotropical migrant songbirds.

This program complied with terms and conditions set forth by U.S. Fish and Wildlife Service (USFWS) in their Biological Opinion on Reclamation's Lower Colorado River Operations and Maintenance – Lake Mead to Southerly International Boundary (USFWS 1997). According to this Biological Opinion, Reclamation was directed to conduct cowbird trapping adjacent to WIFL habitat where parasitism rates exceeded 10 percent. Biologists from Reclamation's Technical Service Center, in cooperation with Reclamation's Lower Colorado Regional Office, have conducted the BHCO control program starting in 1998. The results of the program have been documented in four annual reports (White et al. 1998, White and Best 1999, White et al. 2001, and White et al. 2002). The program included (1) BHCO trapping in an attempt to reduce parasitism, (2) avian point counts to estimate relative abundance of BHCOs and host species, and (3) nest monitoring to determine parasitism rates and nest success.

The occurrence of a breeding population of WIFLs, a rich and diverse population of breeding neotropical migratory host species, and initial population estimates of BHCOs at Alamo Lake State Wildlife Area (SWA) and Bill Williams River National Wildlife Refuge (NWR) indicated that these areas were suitable sites to implement a cowbird control program. For this study, trapping was conducted for 3 consecutive years from 1999 to 2001. As a result, 1,341 and 526 BHCOs were removed from the populations at the Alamo Lake SWA and Bill Williams River NWR, respectively. In 1998, trapping was conducted in limited areas for one season at the Havasu NWR where 232 BHCOs were removed (White et al. 1998). In separate studies, trapping was conducted from 1996 to 1998 at the Bill Williams River NWR where 621 BHCOs were removed (Morrison and Averill-Murray 2002).

The results from our evaluation of the control program indicated that BHCO populations in riparian habitat at both sites were reduced to levels that may have lowered the parasitism potential during the program (White et al. 2002). BHCO capture rates dropped about 60 percent per year at the Alamo Lake SWA and Bill Williams River NWR. BHCO detection rates also decreased and became much lower than untrapped sites along the mainstem Lower Colorado River. BHCO to host ratios were reduced at both Alamo Lake SWA and Bill Williams NWR,

but remained consistently higher at Havasu NWR where trapping had been suspended after 1998. Finally, during BHCO control, our nest monitoring of several host species, including WIFLs, indicated parasitism rates in study plots dropped from 8 percent to 1 percent at the Alamo Lake SWA and remained at zero at the Bill Williams River NWR. Parasitism of WIFL nests has ranged from 15 percent to 30 percent at Havasu NWR from 1998 to 2004 (McKernan and Braden 2002; SWCA 2004; Olson pers. com. 2004).

BHCO trapping was terminated following the summer of 2001 as a result of re-initiation of Section 7 consultation with the USFWS. The current Biological Opinion (USFWS 2002) does not require cowbird trapping as a protective measure for the WIFL. Instead, a study was initiated beginning in 2002 to determine the effectiveness of trapping on WIFL reproductive success and population numbers[1]. Concurrently, biologists from the Technical Service Center have continued to conduct point counts and nest monitoring at Alamo Lake SWA and Bill Williams River NWR to monitor the response of the avian community during the three breeding seasons after the cessation of BHCO trapping (White and Ryan 2002 and 2003). This report summarizes the results of this follow-up monitoring during avian breeding seasons from 2002 through 2004 and compares BHCO abundances, BHCO and host species abundance ratios, and observed parasitism rates with data collected during the 3-year trapping program from 1999 to 2001.

Methods

Study Area

During 2002-2004, the general study areas were located on the Alamo Lake SWA adjacent to Alamo Lake State Park, Arizona, and on the Bill Williams River NWR, Arizona. These sites were the same ones used in the 1999 to 2001 BHCO control program (White et al. 2002). In addition, we continued BHCO/host species point counts at the Havasu NWR, Arizona, where we conducted one season of limited BHCO trapping in 1998 (White et al. 1998), and where trapping was re-initiated in June 2003 and May 2004 by biologists from SWCA Environmental Consultants (SWCA 2004).

Alamo Lake SWA

The Alamo Lake SWA is located about 64 kilometers (km) northeast of the town of Wenden, Arizona, located in La Paz County. This study area is located in and around the confluence of the Santa Maria, Bill Williams, and the Big Sandy rivers upstream of Alamo Lake Reservoir. The area contained three former trapping sites, three active nest monitoring plots, and two active point count routes (Figure 1).

[1] A separate water transfer Biological Opinion directs Reclamation to control BHCOs below Parker Dam in areas where potential WIFL habitat is suspected pending the results of the controlled study to determine the effectiveness of trapping.

Figure 1

Bill Williams River NWR

The Bill Williams River NWR is located about 32 km south of Lake Havasu City, Arizona. The study site is located entirely within the NWR along the Bill Williams River and included four former trapping sites, three active nest monitoring plots, and one active point count route (Figure 2).

Havasu NWR

The Havasu NWR is located in the vicinity of Topock Marsh along the Colorado River in Arizona, just across the border from Needles, California. Here, we continued point counts for songbird host species and BHCOs along the same transect used since 1998 (White et al. 1998). Point counts were continued to evaluate the ratio of BHCOs to host species at a site where BHCO control was implemented in 1998, but subsequently terminated for 4 years, then re-initiated in 2003. The location of the transect and points were identical to those designated as the "Glory Hole to North Dike" point count transects for the 1998 control program concurrent with our study (Figure 3). McKernan and Braden (2002) conducted WIFL surveys and nest monitoring to determine population levels and parasitism rates of WIFLs through the breeding season of 2002. The study was taken over by SWCA (2004) in 2003 and included the re-initiation of BHCO trapping.

BHCO Point Counts

We conducted weekly or bi-weekly fixed-radius point counts as a measure of BHCO distribution and abundance in the study areas. We used a modified version of the point count methodology described by Ralph et al. (1993) where individual BHCOs were recorded within 60 meters (m) of the observer during 5-minute intervals. We used a 60-m threshold (instead of 50-m) to better compare data with 60-m point counts conducted by Lynn and Averill (1996) in the Lower Colorado River Valley. BHCO point count routes started approximately 30 minutes before sunrise and never continued for more than 3.5 hours. In addition, point count transects were run in reverse order each survey to minimize temporal bias.

Alamo Lake SWA

We conduced weekly or bi-weekly point counts along two established transects within the study area from mid-May through July. These transects were located in and adjacent to riparian habitat in the flood plain area. In 2003, the Brown's Crossing transect was modified to include some riparian and WIFL habitat in the expanding delta with declining reservoir elevations. The Santa Maria River transect was changed after 2001 due to ATV restrictions. The route then followed the host species point count walking transect.

The Brown's Crossing BHCO point count transect (Figure 1, route BC) consisted of 20 points approximately 200 m apart and 3.8 km in length. This transect began in the delta of Alamo Lake and then followed the northwestern edge or the dry riverbed of the Bill Williams River to the confluence of the Big Sandy River.

Figure 2

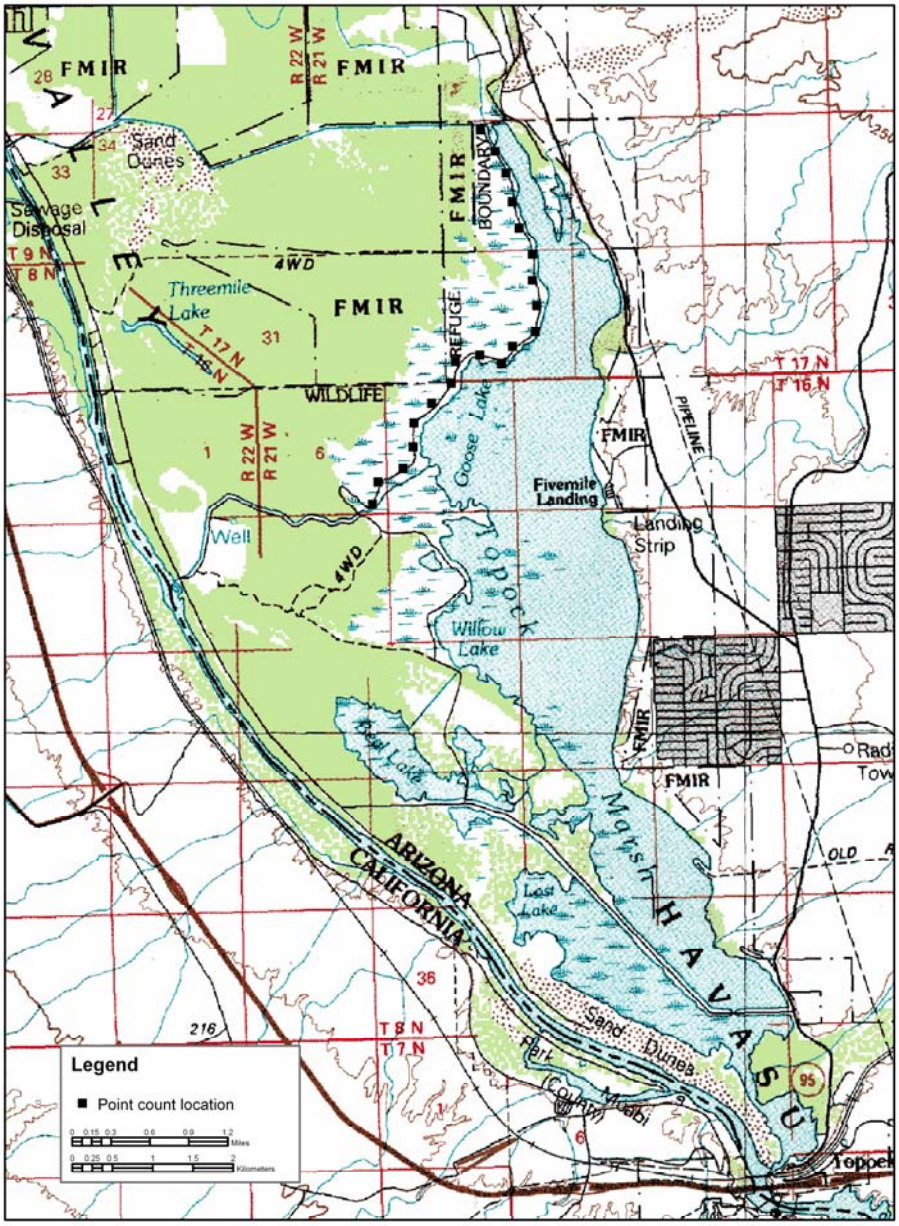


Figure 3. Point count locations at Havasu NWR.

The Santa Maria River BHCO point count transect (Figure 1, route SM) consisted of 20 points ranging from 200 to 400 m apart and was about 4 km in length. This transect formed a loop on both sides of a broad reach of the Santa Maria River flood plain.

Bill Williams River NWR

The BHCO point count route transect ran through or adjacent to riparian habitat for 6 km along the same transect used during the previous seasons (White et al. 2002). This transect ran along the interior road from the gate near the start of the 4-wheel drive road to a point upstream of Mineral Wash (Figure 2). This route consists of 20 points spaced 200 to 400 m apart.

Host Species Point Counts

To monitor the distribution and abundance of the avian community in the BHCO control study area, we conducted 5-minute, 60-m fixed-radius point counts targeting host species and female BHCOs three times during the breeding season along established transects at the Alamo Lake SWA, the Bill Williams River NWR, and the Havasu NWR (Figures 1-3). They were surveyed within the same general time period during the 6 study years. The transects at the Alamo Lake SWA, Bill Williams NWR, and at the Havasu NWR each consisted of 20 points, which were identical to those surveyed since 1998 and were surveyed three times in a 5-week period from mid-May to mid-June. All songbirds were counted and classified as host species if there were any records for that species rearing parasitic young BHCOs based on the compilations of Friedmann and Kiff (1985). Obviously, certain species [i.e., Bell's vireo (BEVI)] are more susceptible and are parasitized more frequently compared to others (i.e., mourning dove). Nevertheless, all species identified as known hosts are included in our analysis.

During the host point counts, we also recorded all BHCOs and distinguished BHCO females by their distinctive "rattle call" as well as visual identification. We evaluated data on the abundance of host species in relationship to female BHCOs to determine and compare the potential for parasitism between the different sites. Robinson et al. (1993) suggested that the ratio of female cowbirds to hosts detected in fixed-radius point counts could be used as a crude index of parasitism intensity at the community level. They stated that ". . . ratios of 0.05-0.10 cowbird females:host males detected within fixed-radius point counts corresponded with very high levels of brood parasitism for most neotropical migrants." Thus, we have used the ratio of female BHCOs and individual host birds observed concurrently during point counts as an index to evaluate trends in BHCO parasitism.

Nest Monitoring

We conducted nest searches and nest monitoring for all potential host species at the Alamo Lake SWA and the Bill Williams NWR within three plots at each site. This was done in proximity to previous BHCO trapping sites and existing point count transects to determine parasitism rates and any correlations between the abundance of BHCOs, the parasitism rates of host songbird species nests, and the effects of previous BHCO removal. In addition, in coordination with Arizona Game and Fish biologists, we monitored WIFL nests at the Alamo Lake SWA in all

years except 2000. Arizona Game and Fish protocol was used when monitoring WIFL nests, with emphasis placed on minimizing disturbance.

For each species and site, we calculated the proportion of nests that was parasitized, predated, abandoned, or successfully hatched or fledged at least one host chick. For consistent and comparable analysis, we compared the year-to-year variation of parasitism and other variables for the four most common host species: Abert's towhee (ABTO), BEVI, WIFL, and yellow-breasted chat (YBCH). In addition, as a quantitative indicator of nest success, we used a "modified Mayfield index" used by Lynn (1996) during avian studies in the Lower Colorado River Valley. The degree of success of each nest was ranked: 0 = did not finish nest construction or no host eggs laid; 1 = at least one host egg laid; 2 = at least one host egg hatched; 3= at least on host chick fledged.

The same nest plots (initially established during the week of May 3, 1999) were monitored during the breeding season from 1999 through 2004. These were placed adjacent to sites where BHCO trapping had previously occurred. The plots contained variable vegetative structure of native and non-native riparian species. Extensive dry monotypic stands of non-native vegetation and upland desert scrub were avoided due to assumed lower songbird density, diversity, and WIFL habitat quality. Plots were located, mapped, and surveyed using GPS and GIS technology (Figures 1 and 2; Tables 1 and 2).

Table 1. Nest monitoring plots at Alamo Lake SWA

Plot Name (Figure 1 code)	Location	Vegetation
Brown's Crossing Plot A (BC-A)	Lake Alamo delta ≤ 0.5 km from Trap 2 location in 2001	Mature Goodding willow/ cottonwood/saltcedar Seepwillow Saltcedar
Brown's Crossing Plot B (BC-B)	Lake Alamo delta ≤ 0.3 km from Trap 3 location in 2001	Mature Goodding willow/ cottonwood/saltcedar Saltcedar
Santa Maria Plot (SM-A)	South side of Santa Maria flood plain ≤ 0.5 km from Trap 1 location in 2001	Mature Goodding willow/ cottonwood/saltcedar Saltcedar

Table 2. Nest monitoring plots at Bill Williams River NWR

Plot Name	Location	Vegetation
Bill Williams River NWR Nest Plot 1 (NP1)	River flood plain near Mineral Wash in location of previous BHCO trap	Scattered mature willow and cottonwood interspersed with saltcedar and mesquite
Bill Williams River NWR Nest Plot 2 (NP2)	River flood plain near Kohen Ranch in location of previous BHCO trap	Scattered mature willow and cottonwood interspersed with saltcedar and mesquite
Bill Williams River NWR Nest Plot 3 (NP3)	River flood plain in "mosquito flats" 1 km downstream of previous BHCO trap	Scattered mature willow and cottonwood interspersed with saltcedar, mesquite, and cattails

Results

Cowbird Point Counts

We used point counts to monitor the abundance of BHCOs in the vicinity of our BHCO control sites. For our analysis, we used point count data collected from the last week in May through the third week of July (outside the late migration period), when the majority of BHCOs are assumed to be summer residents.

Alamo Lake SWA

During the 6 study years, resident period mean BHCO detection rates ranged from 0.01 (2001) to 0.33 (1999) BHCOs per point for Brown's Crossing and 0.01 (2001-2002) to 0.26 (2004) for Santa Maria River. During the trapping years (1999-2001), BHCO detections declined at both sites, which correlated with decreasing BHCO captures rates during our control activities at Alamo Lake SWA (Figure 4). Post trapping data indicate that BHCO mean values have increased from the low detection rates obtained during 2001 (the third year of BHCO control) along the two transects. This correlates with the increase in parasitism rates observed in the adjacent nest monitoring plots (see nest monitoring section).

The annual variation in BHCO numbers observed during point counts was analyzed using ANOVA at the 95-percent confidence level for both the Santa Maria River ($F=11.47$, $df=5, 13$, $P<0.001$) and Brown's Crossing ($F=4.65$, $df=5, 30$, $P<0.003$). Significant decreases in BHCO mean values were indicated from 1999 to 2001. Mean values showed a significant increase between 2001 and 2004. For both areas, no change in BHCO detection rates was indicated between 1999 (first year of trapping) and 2004 (last year of monitoring) suggesting that BHCO abundance has gradually returned to former levels 3 years after of cessation of trapping.

Bill Williams River NWR

During the 6 study years, resident period mean BHCO detection rates ranged from 0.06 (1999) to 0.31 (2004) BHCOs per point along the transect (Figure 5). Unlike what was observed at Alamo Lake, BHCO detections actually increased during the trapping years from a low value during the first year of trapping. This increase continued into the post-trapping years except for a decline in BHCO abundance in 2003. Finally, BHCO abundance increased to the highest level in 2004. ANOVA indicated a significant increase in BHCO mean values ($F=11.47$, $df=5, 13$, $P<0.001$) throughout most of 6 study years. During the trapping years, there was a slight decrease in BHCO capture rates, but the decrease was less than at Alamo Lake (Figures 4 and 5). Prior to our control efforts, 621 BHCOs had been removed from the Bill Williams River NWR from 1996 to 1998 by refuge personnel (Morrison and Averill-Murray 2002).

Host Species Point Counts

Tables 3 to 5 summarize the most recent point count data for the Alamo Lake SWA, Bill Williams River NWR, and Havasu NWR for 2004, and the Appendix contains summaries from

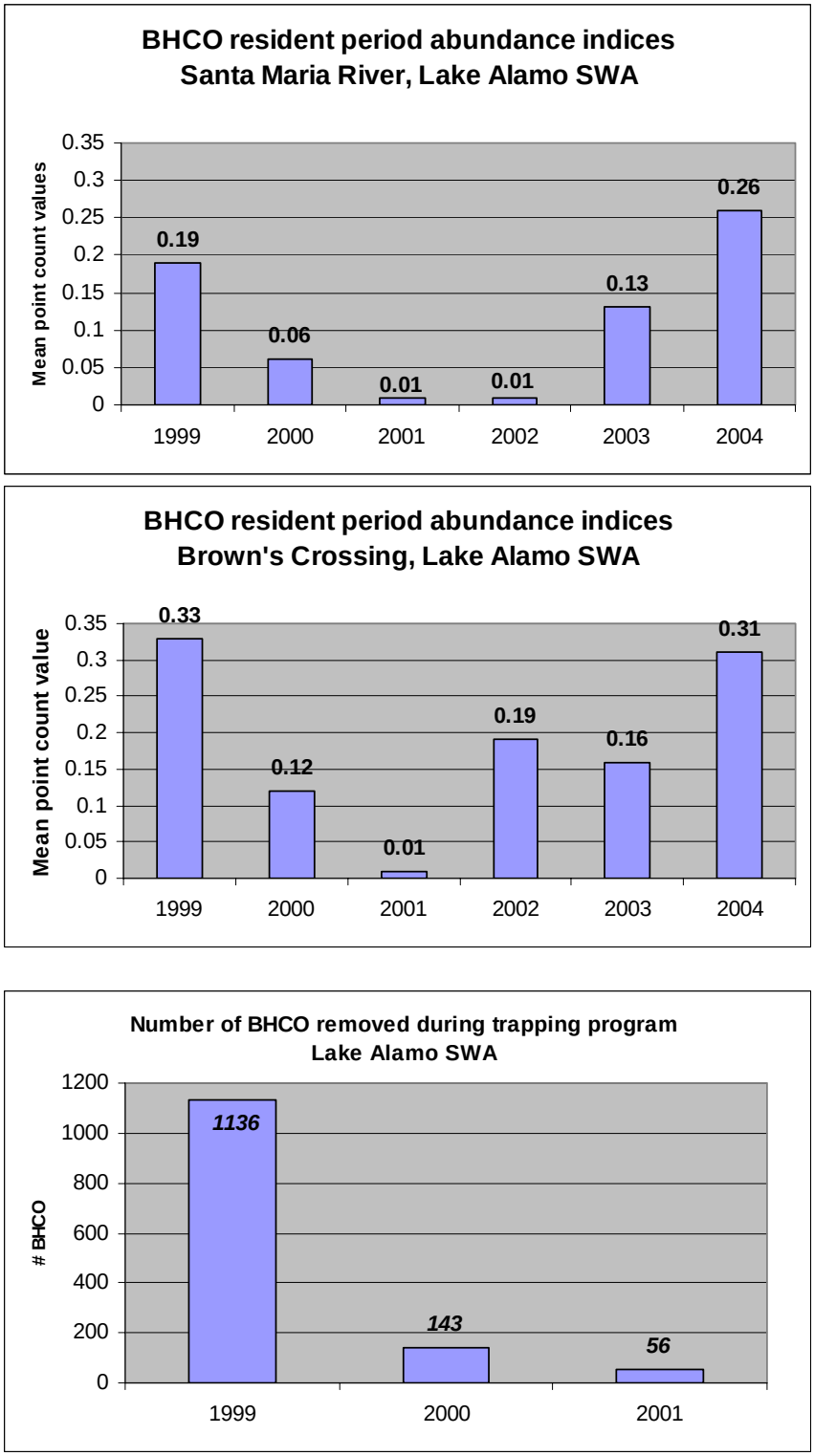
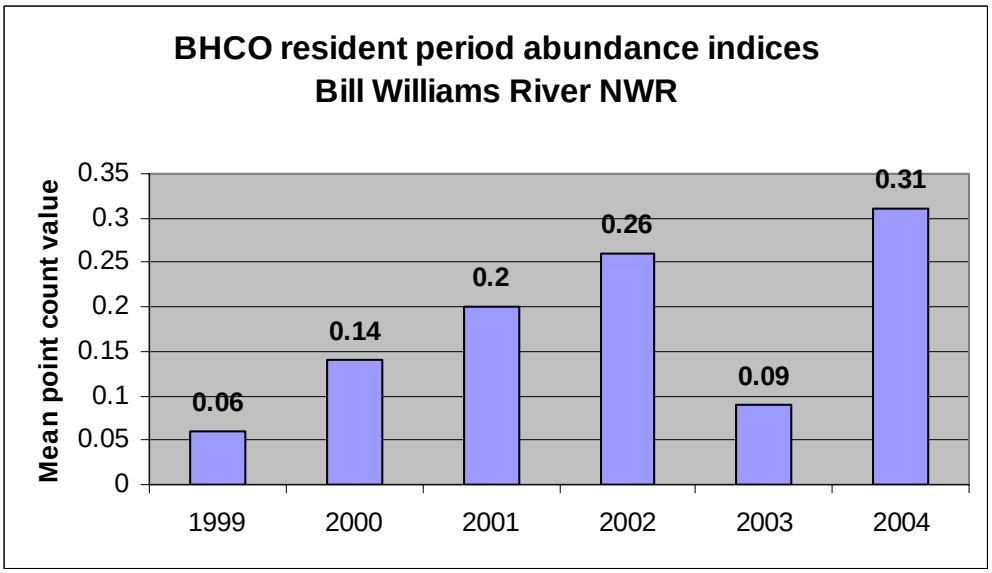


Figure 4. Results of BHCO point counts (1999-2004) and BHCO trapping rates (1999-2001) for Alamo Lake SWA.



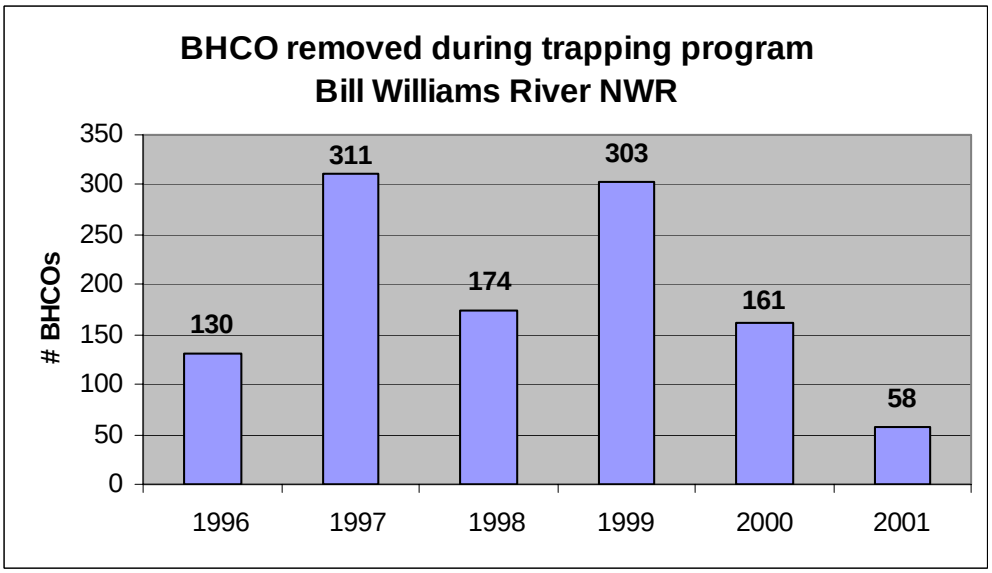


Figure 5. Results of BHCO point counts (1999-2004) and BHCO trapping rates (1996-2001) for Bill Williams River NWR.

Table 3. Results of 2004 point counts for Alamo Lake SWA

Santa Maria River Point Count 5 minute point counts Detections within 60 meters	Survey 1 18-May			Survey 2 2-Jun			Survey 3 16-Jun		
Year 2004	TOTALS	MEAN	SD	TOTALS	MEAN	SD	TOTALS	MEAN	SD
Abert's towhee*	10	0.5	0.69	6	0.3	0.57	11	0.55	0.69
Ash-throated flycatcher	9	0.45	0.69	10	0.5	0.76	13	0.65	0.88
Brown-crested flycatcher	0	0	0.00	0	0	0.00	3	0.15	0.49
Black-chinned hummingbird	2	0.1	0.31	0	0	0.00	1	0.05	0.22
Bell's vireo*	13	0.65	0.59	18	0.9	0.91	12	0.6	0.60
Brown-headed cowbird	5	0.25	0.55	6	0.3	0.57	6	0.3	0.73
Blue grosbeak*	4	0.2	0.41	1	0.05	0.22	3	0.15	0.49
Black-tailed gnatcatcher*	1	0.05	0.22	1	0.05	0.22	0	0	0.00
Cassin's kingbird*	1	0.05	0.22	0	0	0.00	0	0	0.00
Cooper's hawk	1	0.05	0.22	0	0	0.00	0	0	0.00
Common raven	2	0.1	0.45	0	0	0.00	0	0	0.00
Common yellowthroat*	2	0.1	0.31	3	0.15	0.37	6	0.3	0.47
Gambel's quail	26	1.3	5.58	1	0.05	0.22	0	0	0.00
House finch*	0	0	0.00	1	0.05	0.22	0	0	0.00
Ladder-backed woodpecker	1	0.05	0.22	0	0	0.00	3	0.15	0.37
Lesser goldfinch*	0	0	0.00	2	0.1	0.45	0	0	0.00
Lesser nighthawk	0	0	0.00	1	0.05	0.22	12	0.6	1.43
Lucy's warbler*	3	0.15	0.37	3	0.15	0.37	10	0.5	0.89
Mourning dove	3	0.15	0.37	3	0.15	0.37	0	0	0.00
Olive-sided flycatcher*	1	0.05	0.22	0	0	0.00	0	0	0.00
Pacific-slope flycatcher*	2	0.1	0.31	1	0.05	0.22	0	0	0.00
Red-winged blackbird*	1	0.05	0.22	2	0.1	0.45	2	0.1	0.45
Say's phoebe*	1	0.05	0.22	0	0	0.00	0	0	0.00
Song sparrow*	2	0.1	0.45	3	0.15	0.49	0	0	0.00
Summer tanager*	1	0.05	0.22	4	0.2	0.70	2	0.1	0.31
Unidenified songbird	3	0.15	0.49	0	0	0.00	1	0.05	0.22
Vermilion flycatcher*	2	0.1	0.45	3	0.15	0.49	2	0.1	0.45
Virginia rail	1	0.05	0.22	0	0	0.00	0	0	0.00
Western kingbird*	0	0	0.00	0	0	0.00	1	0.05	0.22
Wilson's warbler*	1	0.05	0.22	1	0.05	0.22	0	0	0.00
White-winged dove	6	0.3	0.57	6	0.3	0.47	5	0.25	0.44
Yellow-breasted chat*	24	1.2	1.01	23	1.15	0.88	27	1.35	1.04
Yellow warbler*	10	0.5	0.61	6	0.3	0.66	5	0.25	0.44
TOTAL SPECIES	28	4.65	2.41	22	3.85	1.46	19	4.35	1.81
TOTAL BIRDS	138	6.90	6.75	105	5.25	2.36	125	6.25	2.94
NEOTROPICAL MIGRANT SPECIES	16	3.20	1.99	14	2.65	0.99	14	3.30	1.42
NEOTROPICAL MIGRANT BIRDS	79	3.95	2.67	77	3.85	1.81	98	4.90	2.51
RIPARIAN OBLIGATE SPECIES	9	2.40	1.39	9	2.05	0.60	8	2.45	1.19
RIPARIAN OBLIGATE BIRDS	60	3.00	2.00	71	3.05	1.39	68	3.40	1.73
INVASIVE SPECIES	2	0.25	0.44	1	0.25	0.44	1	0.15	0.37
INVASIVE BIRDS	7	0.35	0.67	6	0.30	0.57	6	0.30	0.73
BHCO HOSTS*	82			81			81		
Brown-headed cowbird (female)	4	0.2	0.41	4	0.2	0.41	4	0.2	0.52
RATIO of BHCO FEMALES:HOSTS	0.05			0.05			0.05		

Table 4. Results of 2004 point counts for Bill Williams NWR

Bill Williams River NWR 5 minute point counts Detections within 60 meters	Survey 19-May			Survey 3-Jun			Survey 17-Jun		
Year 2004	TOTALS	MEAN	SD	TOTALS	MEAN	SD	TOTALS	MEAN	SD
Abert's towhee*	2	0.1	0.31	7	0.35	0.59	3	0.15	0.37
Ash-throated flycatcher	5	0.25	0.44	10	0.5	0.76	10	0.5	0.83
Brown-crested flycatcher	4	0.2	0.41	2	0.1	0.31	5	0.25	0.55
Bell's vireo*	17	0.85	0.81	13	0.65	0.88	10	0.5	0.76
Bewick's wren*	7	0.35	0.49	6	0.3	0.57	2	0.1	0.31
Brown-headed cowbird	14	0.7	1.03	8	0.4	0.68	10	0.5	0.83
Blue grosbeak*	1	0.05	0.22	1	0.05	0.22	0	0	0.00
Black phoebe*	2	0.1	0.31	1	0.05	0.22	1	0.05	0.22
Black-chinned hummingbird	1	0.05	0.22	0	0	0.00	0	0	0.00
Bullock's oriole*	1	0.05	0.22	0	0	0.00	0	0	0.00
Canyon wren	1	0.05	0.22	0	0	0.00	2	0.1	0.31
Common Raven	0	0	0.00	2	0.1	0.31	3	0.15	0.67
Common yellowthroat*	0	0	0.00	3	0.15	0.37	0	0	0.00
Gambel's quail	1	0.05	0.22	2	0.1	0.45	1	0.05	0.22
Gila wodpecker	7	0.35	0.59	5	0.25	0.55	10	0.5	0.76
Great-tailed grackle	0	0	0.00	1	0.05	0.22	0	0	0.00
House finch*	4	0.2	0.52	0	0	0.00	3	0.15	0.49
Ladder-backed woodpecker	3	0.15	0.37	2	0.1	0.45	0	0	0.00
Lesser goldfinch*	4	0.2	0.89	0	0	0.00	0	0	0.00
Lesser nighthawk	0	0	0.00	0	0	0.00	2	0.1	0.45
Lucy's warbler*	0	0.1	0.31	4	0.2	0.41	0	0	0.00
Mourning dove*	1	0.05	0.22	3	0.15	0.49	6	0.3	0.57
Northern rough-winged swallow	0	0	0.00	0	0	0.00	3	0.15	0.67
Olive-sided flycatcher*	1	0.05	0.22	0	0	0.00	0	0	0.00
Phainopepla*	0	0	0.00	1	0.05	0.22	1	0.05	0.22
Pacific-slope flycatcher*	3	0.15	0.37	0	0	0.00	0	0	0.00
Song sparrow*	6	0.3	0.57	4	0.2	0.52	7	0.35	0.99
Summer tanager*	4	0.2	0.41	1	0.05	0.22	1	0.05	0.22
Unidentified songbird	3	0.15	0.67	0	0	0.00	0	0	0.00
Vermilion flycatcher*	1	0.05	0.22	0	0	0.00	5	0.25	0.72
Wilson's warbler*	3	0.15	0.37	0	0	0.00	0	0	0.00
White-winged dove	12	0.6	0.99	18	0.9	0.85	11	0.55	0.69
Yellow-breasted chat*	17	0.85	0.88	18	0.9	0.91	11	0.55	0.51
Yellow warbler*	2	0.1	0.31	3	0.15	0.49	1	0.05	0.22
TOTAL SPECIES	27	5	2.00	23	4.4	1.57	23	4.15	2.16
TOTAL BIRDS	127	6.45	2.87	116	5.8	2.40	110	5.5	3.27
NEOTROPICAL MIGRANT	16	2.8	1.44	10	2.15	0.99	10	1.9	1.37
NEOTROPICAL MIGRANT BIRDS	69	3.55	2.14	56	2.8	1.58	49	2.45	2.21
RIPARIAN OBLIGATE SPECIES	8	2.15	1.18	9	1.85	1.14	6	1.4	1.23
RIPARIAN OBLIGATE BIRDS	52	2.7	1.72	49	2.45	1.47	35	1.75	1.62
INVASIVE SPECIES	1	0.4	0.50	3	0.45	0.51	2	0.35	0.49
INVASIVE BIRDS	14	0.7	1.03	11	0.55	0.69	13	0.65	0.99
BHCO HOSTS*	76			65			51		
Brown-headed cowbird (female)	6	0.3	0.57	5	0.25	0.55	4	0.2	0.41
RATIO of BHCO FEMALES:HOSTS	**0.08**			**0.08**			**0.08**		

Table 5. Results of 2004 point counts for Havasu NWR

Havasu NWR	n=20								
5 minute point counts	**Survey 1**			**Survey 2**			**Survey 3**		
Detections within 60 meters	**20-May**			**4-Jun**			**18-Jun**		
Year 2004	**TOTALS**	**MEAN**	**SD**	**TOTALS**	**MEAN**	**SD**	**TOTALS**	**MEAN**	**SD**
Abert's towhee*	4	0.20	0.41	3	0.15	0.37	10	0.5	0.83
Ash-throated flycatcher	7	0.35	0.67	2	0.1	0.31	4	0.2	0.41
Brown-crested flycatcher	0	0.00	0.00	2	0.1	0.31	0	0	0.00
Black-chinned hummingbird	2	0.10	0.31	2	0.1	0.31	5	0.25	0.55
Bewick's wren*	8	0.40	0.68	6	0.3	0.57	2	0.1	0.31
Brown-headed cowbird	34	1.70	2.70	12	0.6	0.99	10	0.5	0.76
Blue grosbeak*	8	0.40	0.75	4	0.2	0.41	7	0.35	0.59
Black-tailed gnatcatcher*	1	0.05	0.22	0	0	0.00	1	0.05	0.22
Common yellowthroat*	7	0.35	0.75	14	0.7	0.73	10	0.5	0.61
Gambel's quail	0	0.00	0.00	1	0.05	0.22	0	0	0.00
Great-tailed grackle	15	0.75	1.02	7	0.35	0.81	5	0.25	0.55
House finch*	0	0.00	0.00	8	0.4	1.79	0	0	0.00
Ladder-backed woodpecker	1	0.05	0.22	1	0.05	0.22	1	0.05	0.22
Lucy's warbler*	0	0.00	0.00	0	0	0.00	3	0.15	0.37
Mourning dove	7	0.35	0.49	4	0.2	0.41	7	0.35	0.49
Red-winged blackbird*	19	0.95	1.79	19	0.95	1.10	14	0.7	0.92
Song sparrow*	4	0.20	0.41	4	0.20	0.41	9	0.45	0.60
Summer tanager*	1	0.05	0.22	1	0.05	0.22	0	0	0.00
Unidentified warbler*	2	0.10	0.31	0	0	0.00	0	0	0.00
Willow flycatcher*	0	0.00	0.00	1	0.05	0.22	1	0.05	0.22
Wilson's warbler*	1	0.05	0.22	0	0	0.00	0	0	0.00
White-winged dove	25	1.25	1.37	23	1.15	1.14	20	1	0.86
Western wood pewee*	1	0.05	0.22	0	0	0.00	0	0	0.00
Yellow-brested chat*	22	1.10	0.97	23	1.15	0.88	18	0.9	0.91
Yellow warbler*	2	0.10	0.31	3	0.15	0.49	3	0.15	0.37
Yellow-headed backbird*	0	0.00	0.00	2	0.1	0.31	0	0	0.00
TOTAL SPECIES	20	5.05	1.73	21	4.85	1.50	18	5.1	1.77
TOTAL BIRDS	171	8.55	4.72	142	7.1	3.42	130	6.5	2.44
NEOTROPICAL MIGRANT SPECIES	10	1.90	1.17	10	2.1	0.97	8	2.1	1.25
NEOTROPICAL MIGRANT BIRDS	53	2.65	1.79	54	2.7	1.42	51	2.55	1.43
RIPARIAN OBLIGATE SPECIES	6	1.55	1.00	8	2	1.03	7	2.1	1.07
RIPARIAN OBLIGATE BIRDS	44	2.20	1.61	52	2.6	1.39	51	2.55	1.50
INVASIVE SPECIES	2	1.00	0.56	2	0.6	0.60	2	0.55	0.60
INVASIVE BIRDS	49	2.45	3.14	19	0.95	1.23	15	0.75	0.91
BHCO HOSTS*	87			92			85		
Brown-headed cowbird (female)	16	0.80	1.24	2	0.1	0.31	6	0.3	0.47
RATIO of BHCO FEMALES:HOSTS	**0.18**			**0.02**			**0.07**		

1999-2003. Data on the relative abundance of individual species are presented as well as pooled data for species groups including BHCOs, BHCO female to hosts ratios, neotropical migrants, riparian obligates, and invasive species (opportunistic invaders of disturbed habitat which include grackles, crows, ravens, and cowbirds).

Alamo Lake SWA

Overall, the number of pooled bird group detections, including neotropical migrants and riparian obligates, experienced a significant decline in 2002 (Figure 6). ANOVA indicated a significant reduction of neotropical migrants during the mid-June counts in 2002, followed by some increase by 2004 ($F=3.52$, $df=3, 76$, $P<0.0008$). There was also a reduction in numbers of riparian obligate birds in 2002 ($F=2.90$, $df=3, 76$, $P<0.05$), but the increase by 2004 was not statistically significant.

Most common host species during the study were consistently YBCH, BEVI, and ABTO. YBCH mean detection rates ranged from 0.8 to 1.6 birds/point with the low value in 2002; high in 2001; BEVI from 0.55 in 2000 to 0.90 in 1999; ABTO from 0.45 in 2002 to 1.30 in 2001. The only statistical difference in the decreased annual detection rates for these individual species was for YBCH between 2001 and 2002 ($t=-3.74$, $P<0.03$). Detection rates for the yellow warbler (YEWA), a species of regional concern, were relatively low ranging from 0.12 to 0.37. YEWA lowest values were observed in 1999 and 2002; higher values were observed in 2001 and 2004.

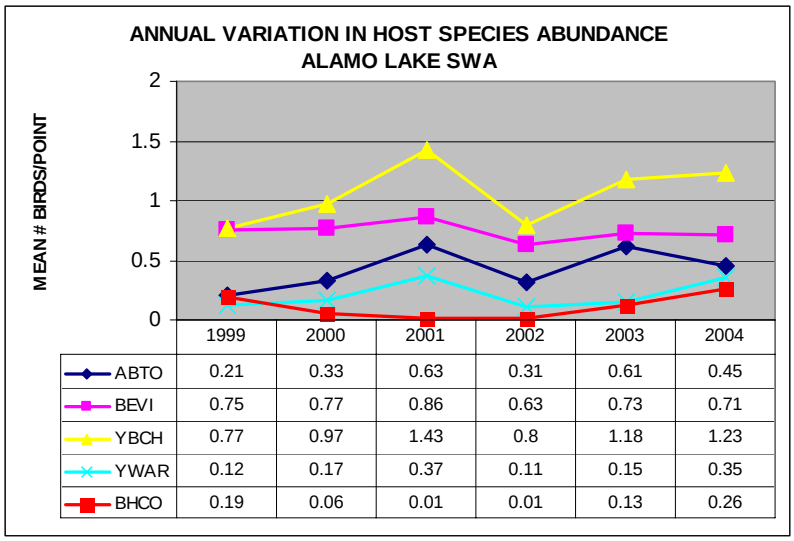
In 2004, the total of individual host birds ranged from 82 on May 18, to 81 on June 2 and June 16. The number of BHCO females was four on all those dates. From this we calculated a cowbird female:host ratio of 0.05 which was higher than the previous years, which ranged from 0 in 2001 (last year of trapping) to 0.03 in 2002 and 2003. However, ANOVA indicated that the apparent ratio increase in 2004 was not significant at the 95 percent confidence level ($F=1.94$, $df=5, 12$, $P<0.17$).

Bill Williams River NWR

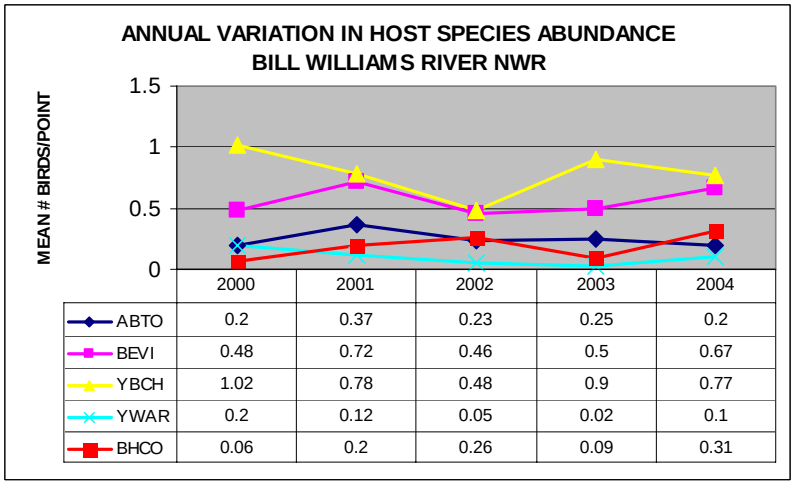
Overall, the number of pooled bird group detections including neotropical migrants and riparian obligates experienced a significant decline in 2002 (Figure 6). ANOVA indicated a significant reduction of neotropical migrants in 2002 ($F=8.27$, $df=236$, $P<0.0001$). There was also a reduction in numbers of riparian obligate birds in 2002 ($F=6.47$, $df=3, 236$, $P=0.003$).

Similar to Alamo Lake SWA, the most abundant host species were YBCH, BEVI, and ABTO. YBCH mean detection rates ranged from 0.5 to 1.0 birds/point with the low in 2002; high value in 2000; BEVI from 0.47 in 2002 to 0.72 in 2001; ABTO from 0.20 in 2000 and 2004 to 0.37 in 2001. Statistical differences in the annual detection rates were indicated for YBCH between 2002 and 2003 ($t=-5.0$, $P<0.008$) and for BEVI between 2002 and 2004 ($F=3.98$, $df=4, 10$, $P<0.035$). Detection rates for the YEWA ranged from 0.02 (2002 and 2003) to 0.20 (2000).

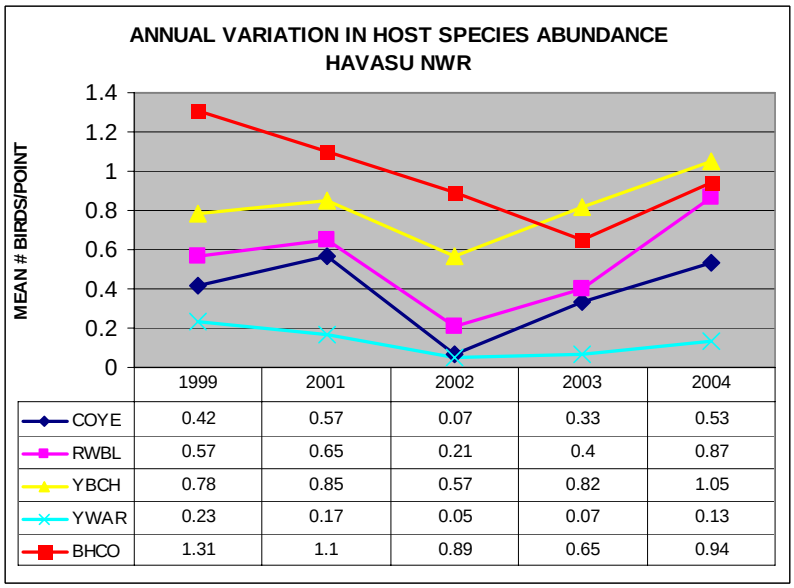
In 2004, the total number of individual host birds ranged from 76 on May 19 to 65 on June 3, and 51 on June 18. BHCO female numbers ranged from 6, 5, and 4 on those dates, respectively. From this, we calculated cowbird female:host ratios of 0.08 which increased from the 0.01 to 0.04 ratios of previous years. ANOVA indicated that the 2004 ratios had increased significantly from the 2000 to 2003 ratios ($F=4.48$, $df=4, 10$, $P<0.025$).



	1999	2000	2001	2002	2003	2004
ABTO	0.21	0.33	0.63	0.31	0.61	0.45
BEVI	0.75	0.77	0.86	0.63	0.73	0.71
YBCH	0.77	0.97	1.43	0.8	1.18	1.23
YWAR	0.12	0.17	0.37	0.11	0.15	0.35
BHCO	0.19	0.06	0.01	0.01	0.13	0.26



	2000	2001	2002	2003	2004
ABTO	0.2	0.37	0.23	0.25	0.2
BEVI	0.48	0.72	0.46	0.5	0.67
YBCH	1.02	0.78	0.48	0.9	0.77
YWAR	0.2	0.12	0.05	0.02	0.1
BHCO	0.06	0.2	0.26	0.09	0.31



	1999	2001	2002	2003	2004
COYE	0.42	0.57	0.07	0.33	0.53
RWBL	0.57	0.65	0.21	0.4	0.87
YBCH	0.78	0.85	0.57	0.82	1.05
YWAR	0.23	0.17	0.05	0.07	0.13
BHCO	1.31	1.1	0.89	0.65	0.94

Figure 6. Annual variation of detection rates for selected species recorded during host species point counts.

Havasu NWR

Similar to the trends at Alamo Lake SWA and Bill Williams River, the number of pooled bird group detections including neotropical migrants and riparian obligates experienced a significant decline in 2002 (Figure 6). ANOVA indicated a significant reduction of neotropical migrants in 2002 and an increase by 2004 ($F=7.33$, df=3, 236, $P=0.0001$). There was also a reduction in numbers of riparian obligate birds in 2002 ($F=5.37$, df=3, 76, $P=0.003$).

Most common host species during the study were consistently YBCH, red-winged blackbird (RWBL), common yellowthroat (COYE), and ABTO. YBCH mean detection rates ranged from 0.57 to 1.1 birds/point with the low in 2002; high value in 2004; RWBL from 0.22 in 2002 to 0.87 in 2004; COYE from 0.07 in 2002 to 0.57 in 2001; ABTO from 0.10 in 1999 to 0.53 in 2001.

Statistical difference in the annual detection rates for individual species for low values in 2002 and increased values by 2004 was indicated by t-tests: YBCH ($t=-5.48$, $P<0.006$), COYE ($t=-3.74$, $P=0.02$); RWBL ($t=-6.32$, $P=0.003$). For ABTO, ANOVA indicated a statistical difference between the high value observed in 2001 and all other years ($F=6.28$, df=4, 10, $P<0.009$). Detection rates for the YEWA (a species of regional concern) were relatively low ranging from 0.05 (2002) to 0.23 (1999).

In 2004, the total number of individual host birds ranged from 92 on June 4 to 85 on June 18. In contrast to the Alamo Lake SWA and the Bill Williams River NWR, BHCOs were more abundant than most host species. BHCO detection rates ranged from 1.70 to 0.50 decreasing during the three-survey period. ANOVA did not indicate a significant difference in BHCO abundance between the 6 years. However linear regression indicated a weak declining trend from 1999 to 2004 at the 90 percent confidence level (R-squared=24.5 percent, df=1, 13, $P<0.061$).

Numbers of BHCO females ranged from 16, 2, and 6 during 2004 point counts at Havasu. From this, we calculated cowbird female:host ratios ranging from 0.18 to 0.03 which declined through the season, increased from mid-June values of the previous year, but represented a decrease from 1999-2002 ratios. ANOVA indicated that the 2003 ratios had increased significantly from the 1999 and 2002 ratios ($F=4.48$, df=4, 10, $P<0.025$), but the 2004 ratio was not statistically different.

Nest Monitoring

Alamo Lake SWA

During the 6 study years, a total of 378 nests of 14 species including 74 WIFL nests were monitored[2]. The number of WIFL nests found each year ranged from 10 to 24 with the high in 2001 and low in 2004. Table 6 and Figure 7 and 8 summarize the nest monitoring results from 1999-2004 for the four common host species (ABTO, BEVI, WIFL, YBCH). The Appendix contains detailed data on individual nests of those and other species.

[2] The total does not include the 13 WIFL nests found but not monitored in year 2000.

Table 6. Nest monitoring results for four host species at Alamo Lake SWA—1999-2004

1999 Results:

Species	*Total Nests*	*Parasitzed*	*Predated*	*Abandoned/Other*	*Successful*
Abert's towhee	2	0	0	0	2
Bell's vireo	5	0	0	0	5
Southwestern willow flycatcher	13	1	1	3	8
Yellow-breasted chat	8	1	0	3	4
TOTAL	**28**	**2 (7%)**	**1 (4%)**	**6 (21%)**	**19 (68%)**

2000 Results:

Species	*Total Nests*	*Parasitzed*	*Predated*	*Abandoned/Other*	*Successful*
Abert's towhee	4	1	0	0	3
Bell's vireo	3	0	0	0	3
Southwestern willow flycatcher	13	**?**	**?**	**?**	**?**
Yellow-breasted chat	27	0	2	4	21
TOTAL	**34**	**1 (3%)**	**2 (6%)**	**4 (12%)**	**27 (79%)**

2001 Results:

Species	*Total Nests*	*Parasitzed*	*Predated*	*Abandoned/Other*	*Successful*
Abert's towhee	8	0	1	0	7
Bell's vireo	9	1	1	0	7
Southwestern willow flycatcher	24	0	4	3	17
Yellow-breasted chat	28	0	1	1	26
TOTAL	**69**	**1 (1%)**	**7 (10%)**	**4 (6%)**	**57 (83%)**

2002 Results:

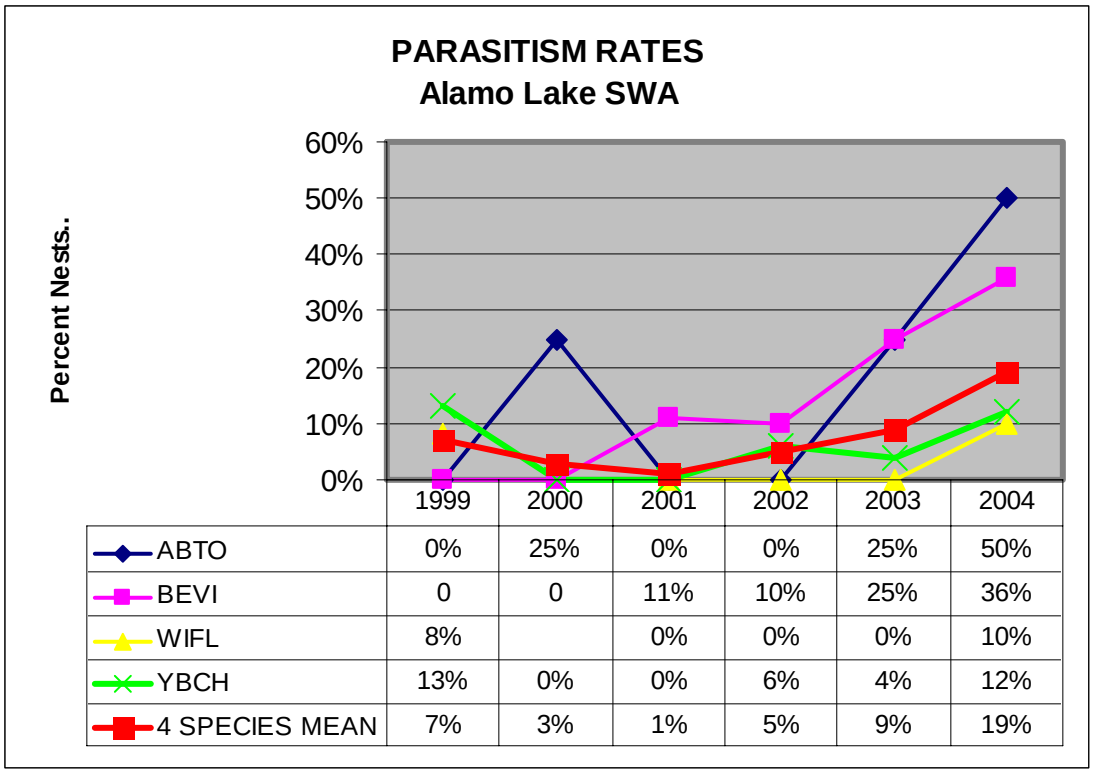
Species	*Total Nests*	*Parasitzed*	*Predated*	*Abandoned/Other*	*Successful*
Abert's towhee	4	0	2	1	1
Bell's vireo	10	1	4	1	4
Southwestern willow flycatcher	12	0	3	1	8
Yellow-breasted chat	17	1	4	0	13
TOTAL	**43**	**2 (5%)**	**13 (30%)**	**3 (7%)**	**25 (60%)**

2003 Results:

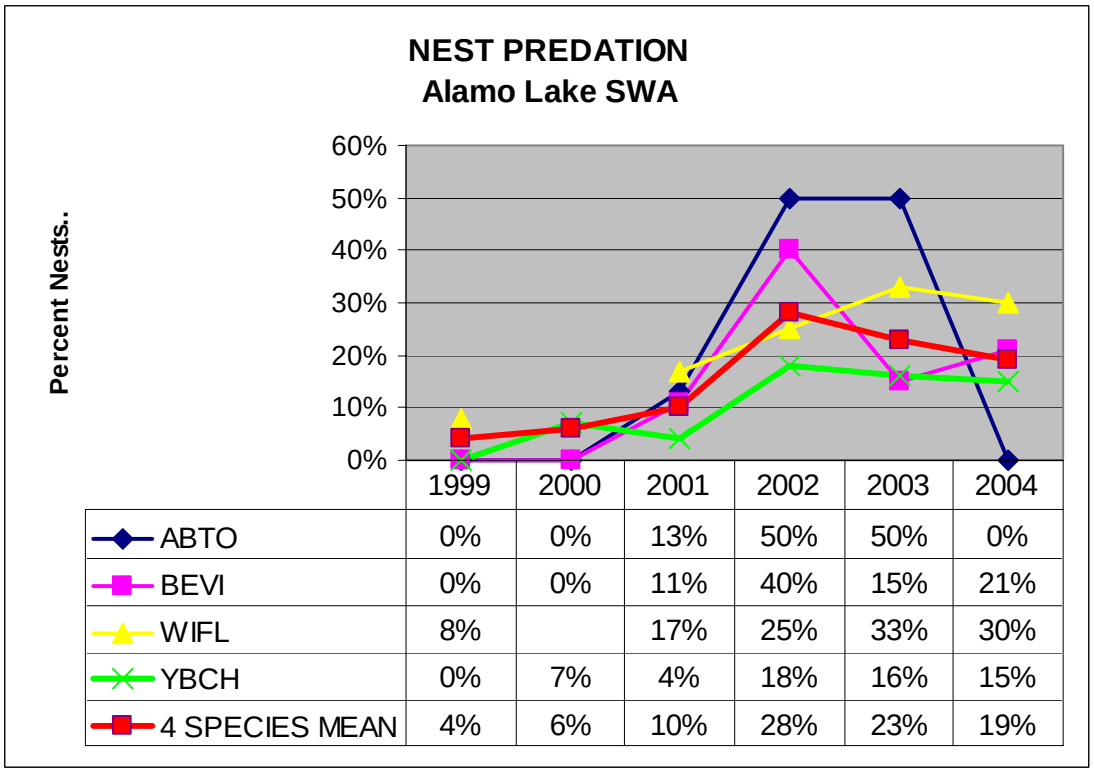
Species	*Total Nests*	*Parasitzed*	*Predated*	*Abandoned/Other*	*Successful*
Abert's towhee	4	1	2	0	1
Bell's vireo	12	3	1	2	6
Southwestern willow flycatcher	15	0	5	0	10
Yellow-breasted chat	25	1	4	2	18
TOTAL	**56**	**5 (9%)**	**12 (21%)**	**4 (7%)**	**45 (80%)**

2004 Results:

Species	*Total Nests*	*Parasitzed*	*Predated*	*Abandoned/Other*	*Successful*
Abert's towhee	2	1	0	0	2
Bell's vireo	14	4	4	1	9
Southwestern willow flycatcher	10	1	3	2	5
Yellow-breasted chat	26	3	5	4	16
TOTAL	**52**	**9 (17%)**	**12 (23%)**	**7 (13%)**	**32 (62%)**

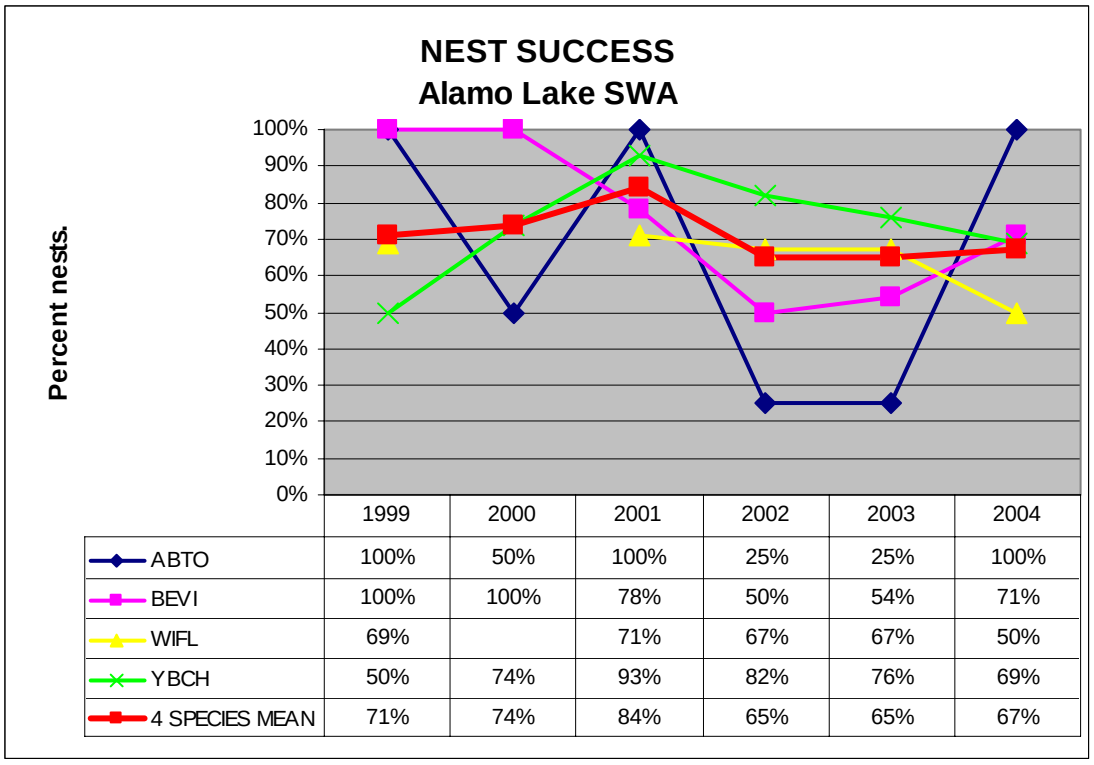


	1999	2000	2001	2002	2003	2004
ABTO	0%	25%	0%	0%	25%	50%
BEVI	0	0	11%	10%	25%	36%
WIFL	8%		0%	0%	0%	10%
YBCH	13%	0%	0%	6%	4%	12%
4 SPECIES MEAN	7%	3%	1%	5%	9%	19%

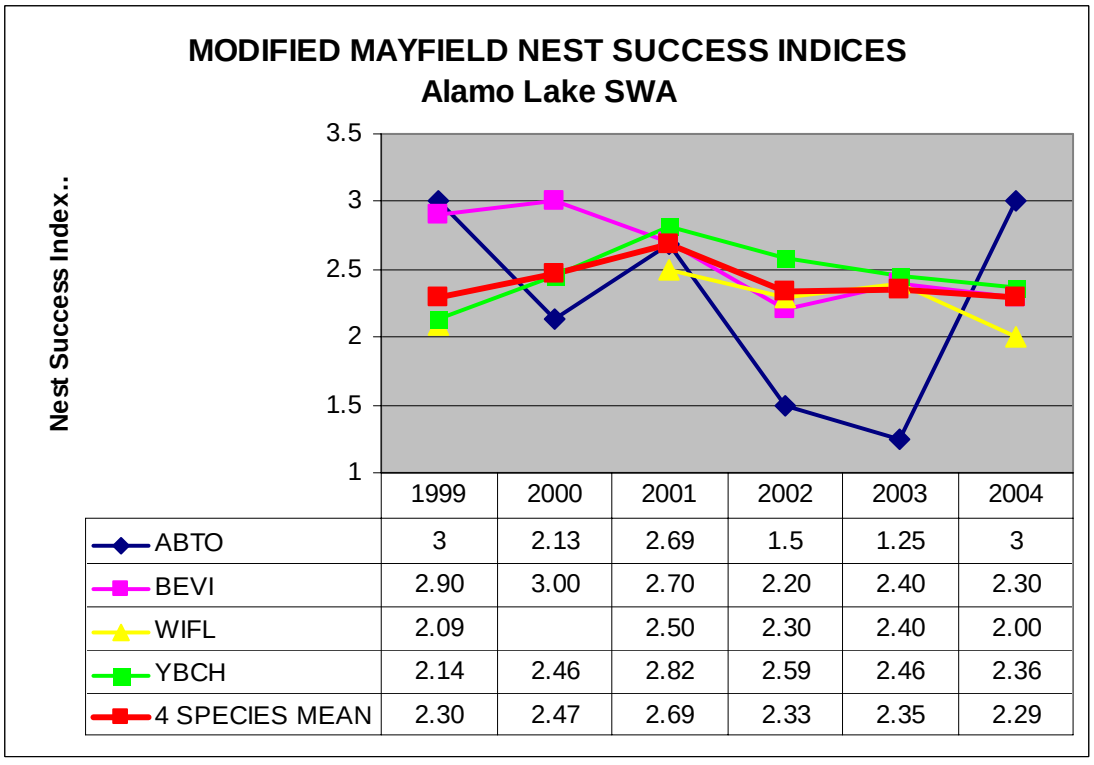


	1999	2000	2001	2002	2003	2004
ABTO	0%	0%	13%	50%	50%	0%
BEVI	0%	0%	11%	40%	15%	21%
WIFL	8%		17%	25%	33%	30%
YBCH	0%	7%	4%	18%	16%	15%
4 SPECIES MEAN	4%	6%	10%	28%	23%	19%

Figure 7. Parasitism and nest predation observed at Alamo Lake for four host species.



	1999	2000	2001	2002	2003	2004
ABTO	100%	50%	100%	25%	25%	100%
BEVI	100%	100%	78%	50%	54%	71%
WIFL	69%		71%	67%	67%	50%
YBCH	50%	74%	93%	82%	76%	69%
4 SPECIES MEAN	71%	74%	84%	65%	65%	67%



	1999	2000	2001	2002	2003	2004
ABTO	3	2.13	2.69	1.5	1.25	3
BEVI	2.90	3.00	2.70	2.20	2.40	2.30
WIFL	2.09		2.50	2.30	2.40	2.00
YBCH	2.14	2.46	2.82	2.59	2.46	2.36
4 SPECIES MEAN	2.30	2.47	2.69	2.33	2.35	2.29

Figure 8. Nest success observed at Alamo Lake for four host species.

During the 6 study years, combined parasitism rates for the four species ranged from 1 percent in 2001 to 19 percent in 2004 with an increasing trend after the termination of the BHCO control program. BEVI nests experienced the overall highest parasitism with rates increasing from zero in 1999 to 36 percent in 2004. One WIFL nest was parasitized in 1999 and one in 2004, which represents an overall 2.7 percent rate for the 74 WIFL nests monitored (7.7 percent in 1999; 10.0 percent for 2004).

Predation rates also increased during the post trapping years. BEVI nest predation increased from 11 percent in 2001 to 40 percent in 2002; YBCH increased from 4 percent in 2001 to 15 percent in 2004. Predation rates on WIFL nests increased from 8 percent to 17 percent in the trapping years; and further increased from 25 percent to 33 percent in the post trapping years.

Nest success, as a measure of the percent of host nests that produce at least one host nestling, ranged from 65 percent in 2002 to 84 percent in 2001 with a slight declining trend following trapping. During 2004, WIFLs experienced the lowest nest success rate: out of 10 WIFL nests, 1 nest was parasitized, 3 were predated, 2 were abandoned, and 5 were successful.

Nest success measured by modified Mayfield indices for combined four species means (ABTO, BEVI, YBCH and WIFL) showed increasing trends during trapping, followed by a decreasing trend post trapping (Figure 8). T-tests indicated a statistical reduction of mean Mayfield indices between 2001 and 2004 for WIFL at 90 percent confidence ($t=1.98$, $P<0.06$). Mann-Whitney test indicated a significant increase in nesting success between 1999 and 2001 for YBCH ($w=68.0$, $P<0.09$).

Bill Williams River NWR

During the 6 study years a total of 143 nests of 13 species including 9 WIFL nests were monitored[3]. The number of WIFL nests that was found each year ranged from zero to four; none were found in 2000 and 2004. Table 7 and Figures 9 and 10 summarize the nest monitoring results from 1999-2004 for the four common host species. The Appendix contains detailed data on individual nests of all species monitored.

Parasitism rates for all species was zero during the 1999-2001 BHCO trapping years with an increasing trend after the termination of the BHCO control program. The combined rates for ABTO, BEVI, YBCH, and WIFL were 10 percent in 2002, 20 percent in 2003, and 21 percent in 2004. BEVIs experienced the highest overall parasitism. None of the 11 WIFL nests were parasitized; WIFL nests were not found in 2000 and 2004.

Nest predation also increased after 2001 from zero in the trapping years to a high of 33 percent in 2003. No WIFL nests were predated. However, predation rates for BEVI were 22 percent and 25 percent in 2002 and 2004; rates for YBCH were 63 percent and 21 percent for 2002 and 2004.

Nest success measured by modified Mayfield indices for combined three species means (BEVI, WIFL, YBCH) and WIFL means showed no apparent trends during trapping, followed by a decreasing trend post trapping (Figure 10). W-test indicated a statistical decrease in the four-species mean Mayfield index from 2001 to 2004 ($W=462$, $P<0.05$).

[3] WIFL nests monitored by SBCM and SWCA contractors.

Table 7. Nest monitoring results for four host species at Bill Williams NWR—1999-2004

1999

Species	# Nests	Parasitzed	Predated	Abandoned/Other	Successful
Abert's towhee	1	0	0	0	1
Bell's vireo	4	0	0	1	3
Southwestern willow flycatcher	1	0	0	0	1
TOTAL	**6**	**0**	**0**	**1 (17%)**	**5 (83%)**

2000

Species	# Nests	Parasitzed	Predated	Abandoned/Other	Successful
Bell's vireo	4	0	0	2	2
Yellow-breasted chat	1	0	0	0	1
TOTAL	**5**	**0**	**0**	**2 (20%)**	**3 (60%)**

2001

Species	# Nests	Parasitzed	Predated	Abandoned/Other	Successful
Southwestern willow flycatcher	2	0	0	0	2
Yellow-breasted chat	8	0	0	1	7
TOTAL	**10**	**0**	**0**	**1 (10%)**	**9 (90%)**

2002

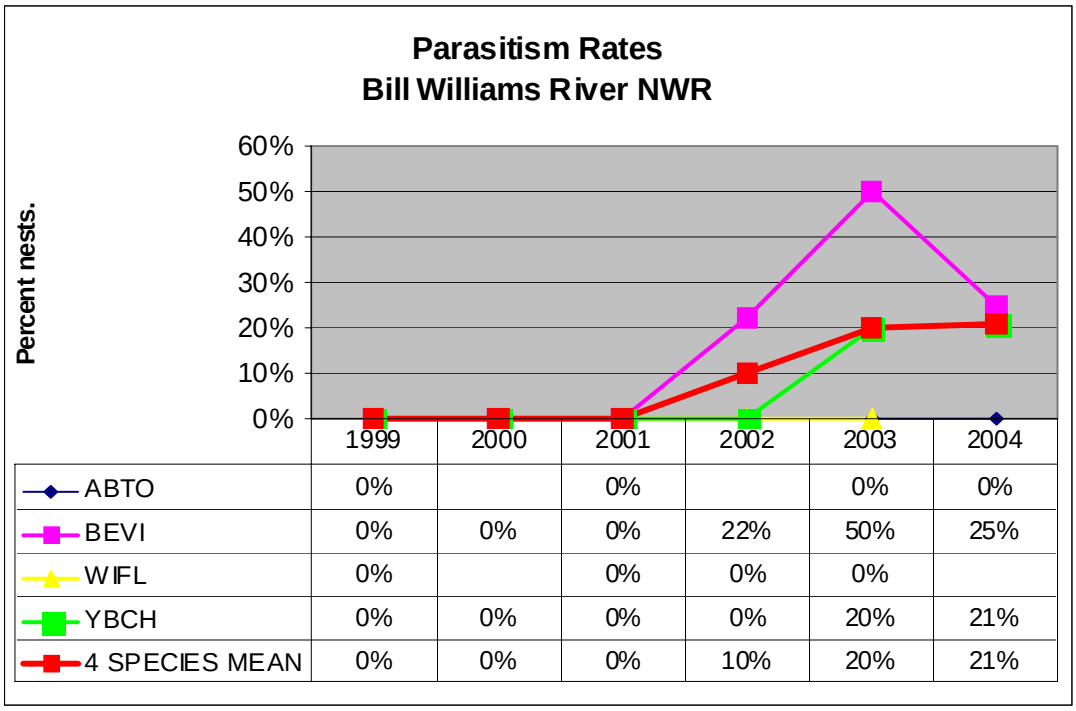
Species	# Nests	Parasitzed	Predated	Abandoned/Other	Successful
Bell's vireo	9	2	2	0	5
Southwestern willow flycatcher	4	0	0	2	2
Yellow-breasted chat	8	0	3	0	5
TOTAL	**21**	**2 (10%)**	**5 (24%)**	**2 (10%)**	**14 (67%)**

2003

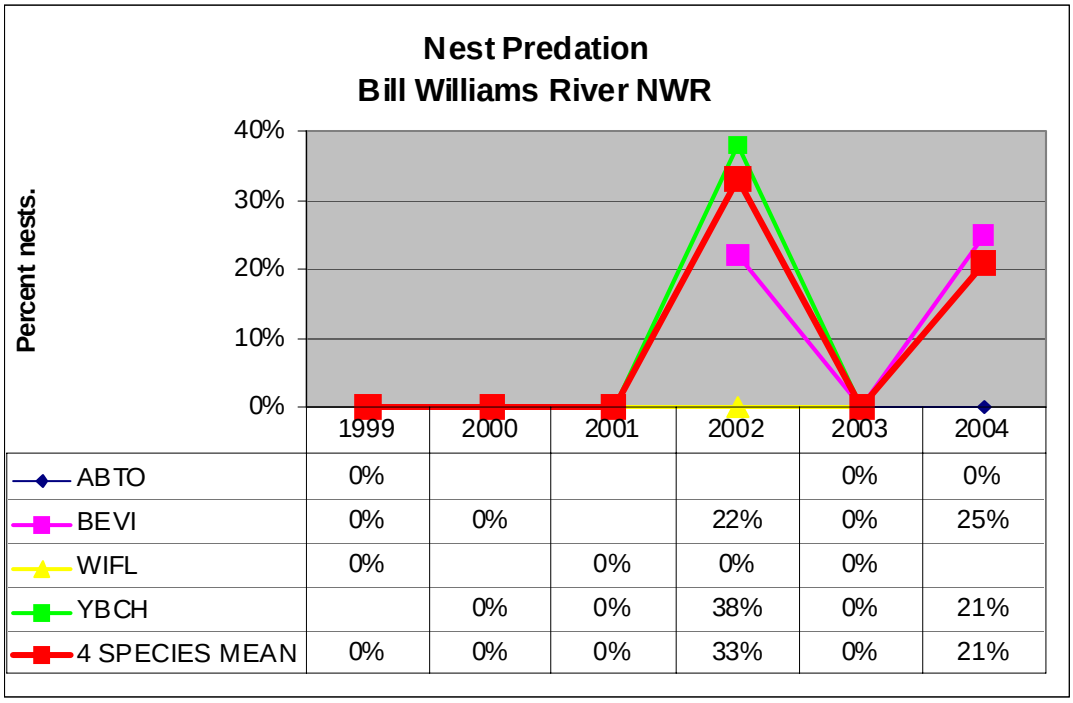
Species	# Nests	Parasitzed	Predated	Abandoned/Other	Successful
Abert's towhee	1	0	0	0	1
Bell's vireo	2	1	0	1	1
Southwestern willow flycatcher	2	0	0	0	2
Yellow-breasted chat	5	1	0	1	4
TOTAL	**10**	**2 (20%)**	**0**	**2 (20%)**	**8 (80%)**

2004

Species	# Nests	Parasitzed	Predated	Abandoned/Other	Successful
Abert's towhee	1	0	0	0	1
Bell's vireo	4	1	1	0	2
Yellow-breasted chat	14	3	3	2	10
TOTAL	**19**	**4 (21%)**	**4 (21%)**	**2 (11%)**	**13 (68%)**

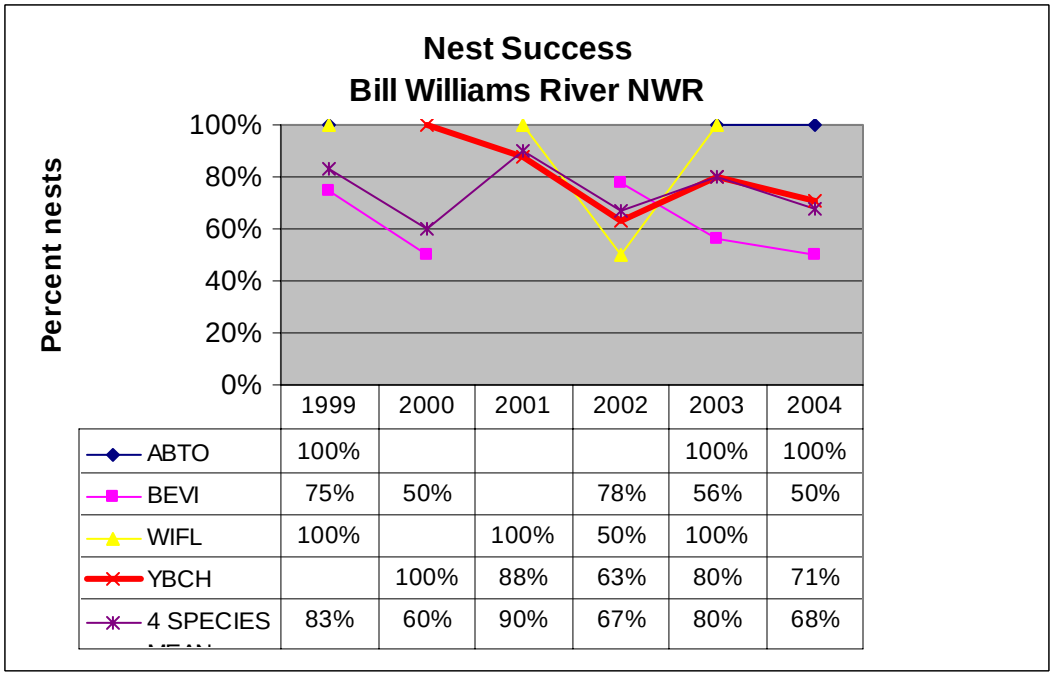


	1999	2000	2001	2002	2003	2004
ABTO	0%		0%		0%	0%
BEVI	0%	0%	0%	22%	50%	25%
WIFL	0%		0%	0%	0%	
YBCH	0%	0%	0%	0%	20%	21%
4 SPECIES MEAN	0%	0%	0%	10%	20%	21%

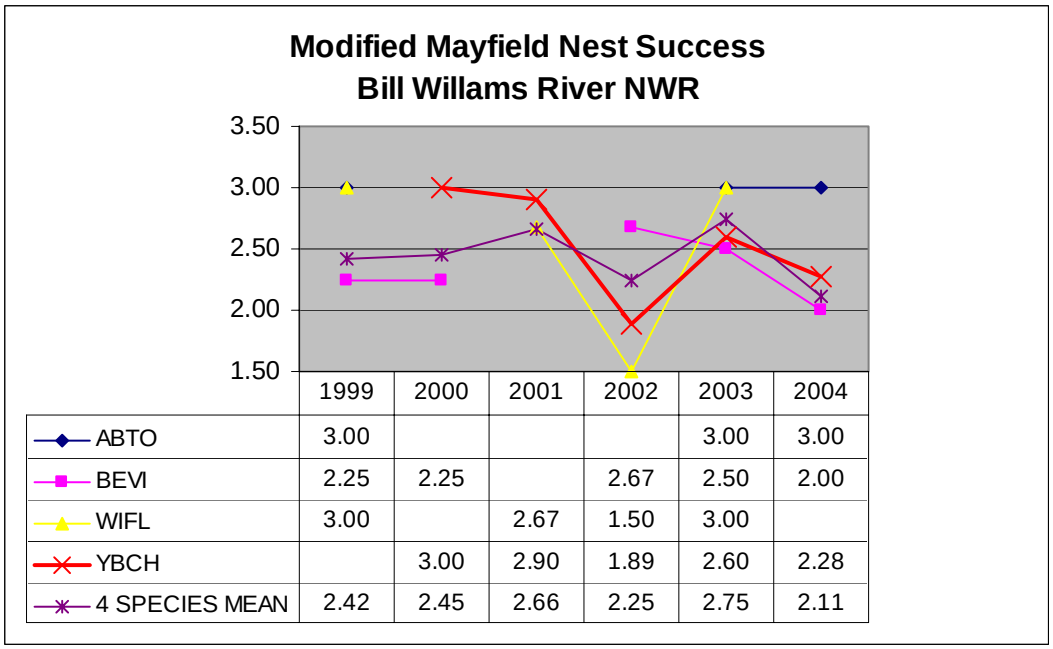


	1999	2000	2001	2002	2003	2004
ABTO	0%				0%	0%
BEVI	0%	0%		22%	0%	25%
WIFL	0%		0%	0%	0%	
YBCH		0%	0%	38%	0%	21%
4 SPECIES MEAN	0%	0%	0%	33%	0%	21%

Figure 9. Parasitism and nest predation observed at Bill Williams River NWR for four host species.



	1999	2000	2001	2002	2003	2004
ABTO	100%				100%	100%
BEVI	75%	50%		78%	56%	50%
WIFL	100%		100%	50%	100%	
YBCH		100%	88%	63%	80%	71%
4 SPECIES	83%	60%	90%	67%	80%	68%



	1999	2000	2001	2002	2003	2004
ABTO	3.00				3.00	3.00
BEVI	2.25	2.25		2.67	2.50	2.00
WIFL	3.00		2.67	1.50	3.00	
YBCH		3.00	2.90	1.89	2.60	2.28
4 SPECIES MEAN	2.42	2.45	2.66	2.25	2.75	2.11

Figure 10. Nest success observed at Bill Williams River NWR for four host species.

Discussion

BHCO Abundance

Compared to sites on the mainstem Colorado River, BHCO numbers have remained relatively low during and following trapping at the Alamo Lake SWA and the Bill Williams River NWR. Much higher BHCO numbers have been found at the Havasu NWR, but with a decreasing trend later in the 2003 and 2004 breeding seasons. The number of cowbirds observed during our point counts at the Alamo Lake SWA and Bill Williams River NWR during 1999-2003 is less than 30 percent of what has been observed along the mainstem lower Colorado River. Point counts conducted by Averill (1996) in 1994 and 1995 found that BHCO abundance averaged 1.24 BHCOs per point along the lower Colorado River. In 1999, 2001, 2002, late-May 2003, and late-May 2004, BHCO abundance ranged from 0.6 to 1.90 along our host species point count route at the Havasu NWR. In mid-June 2003 and 2004, following the start of trapping, the abundance dropped to 0.50.

During the trapping years of 1999 to 2001, BHCO abundance declined at the Alamo Lake SWA. This trend may represent BHCO population reduction during the trapping years and correlates with the decrease in numbers of trapped BHCOs each year from 1999-2001. After trapping was terminated, there was an increase in BHCO abundance from 2002 to 2004. No difference in BHCO abundance was indicated between the first year of trapping (1999) and the third year of post-trapping monitoring (2004), indicating that BHCO numbers are returning to pre-trapping levels after 3 years following termination of trapping. No data on BHCO abundance prior to the start of our BHCO control are available. The gradual increase in BHCO numbers following trapping may indicate a relatively slow immigration rate of BHCOs in an area somewhat isolated from a major BHCO population center, agricultural area, and migration corridor such as the Colorado River.

At the Bill Williams NWR, mean BHCO values actually increased during the 1999 to 2001 trapping period. The first year of trapping (1999) resulted in the lowest BHCO abundance. Except for the decrease observed in 2003, BHCO numbers continued to increase after trapping, and the 2004 abundance exceeded all other years including 1999. The relatively lower BHCO abundance at Bill Williams compared to Alamo Lake may reflect the previous 1996-1998 trapping at the Bill Williams River NWR, which occurred prior to our study. Morrison and Averill (2002) found that the earlier trapping efforts from 1996 to 1998 and decrease in local irrigated agriculture probably resulted in reduced cowbird abundance along the lower Bill Williams River. The closer proximity of the Bill Williams site to the mainstem Colorado River compared to Alamo Lake may result in faster recruitment of BHCOs.

Compared to the Alamo Lake SWA and the Bill Williams River NWR, much higher BHCO abundance was observed at the Havasu NWR during host species point counts from 1999 to 2004. However, BHCO abundance decreased during mid-June 2003, increased by late May 2004, and decreased later in June which may be the result of trapping starting in 2003 (Figure 11). This trend suggests faster BHCO recruitment at Havasu NWR and along the mainstem Colorado River.

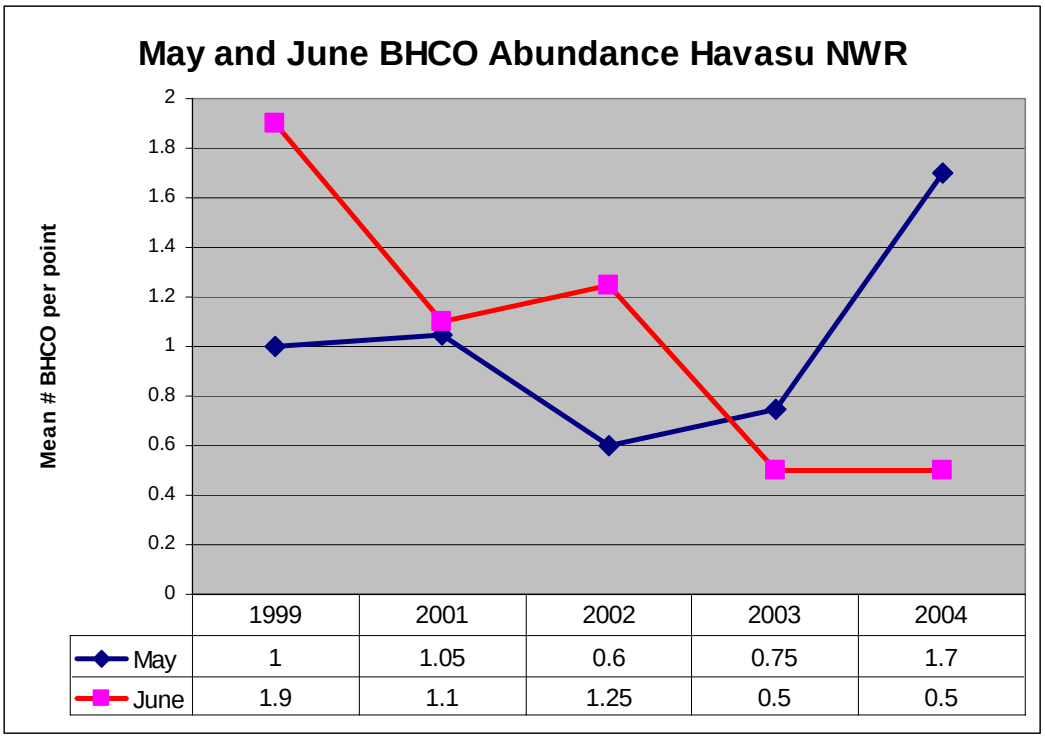


Figure 11. Comparison of May and June BHCO point count detection rates at Havasu NWR.

The decrease in abundance of BHCOs at the Alamo Lake SWA following trapping is similar to a cowbird control program in California which showed significant decline in the number of BHCOs captured from year to year over a 5-year period (Whitfield et al. 1999). However, Reclamation's BHCO control program on the mainstem Rio Grande in New Mexico showed a relatively constant capture rate from 1996 to 2001 (Ahlers and Tisdale-Hein 2001). These contrasting results could indicate that (1) a constant annual immigration of BHCOs occurs along a major north-south oriented continuous migration corridor such as the Rio Grande and Colorado River and (2) lower BHCO immigration occurs in certain riparian areas off the mainstem of such rivers. Ongoing and future BHCO control programs along the mainstem Colorado River could further test this hypothesis.

Host Species Abundance and BHCO Ratios

Our point counts at the Alamo Lake SWA, Bill Williams River NWR, and Havasu NWR documented the continued occurrence of a diverse population of late spring migrants and breeding songbirds including potential host species, riparian obligates, and neotropical migrants. The abundance of several species of songbirds, especially neotropical migrants and riparian obligates, experienced declines in 2002 at Alamo Lake SWA, Bill Williams River NWR, and Havasu NWR. By 2003 or 2004 abundances for many species were increasing toward 2001 levels. Overall, the pooled means of all birds, neotropical migrants, and riparian obligates were higher in all three areas in 2004 compared with 2002. Many species such as YBCH approached

or exceeded 2001 levels, while others such as blue grosbeak and YEWA continued declines at some or all of our study sites.

BHCO abundance followed a different pattern than neotropical migrants and riparian obligates. BHCO abundance decreased to low values in 2001 at Alamo Lake SWA and increased by 2002 at Brown's Crossing and 2003 at Santa Maria River. At Bill Williams River NWR, BHCO abundance increased through 2002, decreased in 2003, then reached high values in 2004. At Havasu, mid-June BHCO abundance was relatively high in 2002, then decreased in 2003 and 2004. Therefore, we cannot necessarily correlate the decrease in BHCO abundances with the decrease in overall avian abundances.

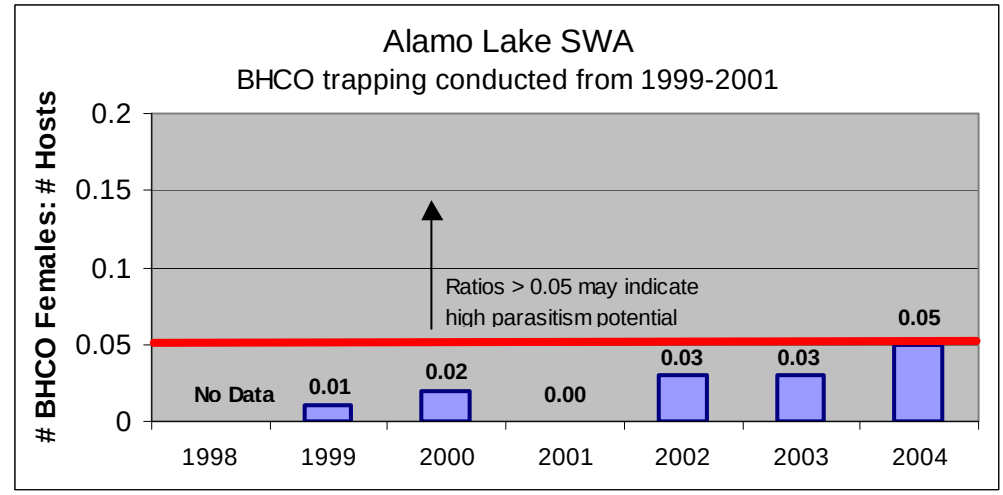
However, the increase in the ratio of BHCO females to host birds beginning in 2002 may be attributable to the decline in abundance host species in relationship to higher numbers of BHCOs. Our data indicates that the mid-June ratio of female BHCOs to host birds at Alamo Lake and Bill Williams has increased since 2001 (Figure 12). The ratios at Alamo Lake SWA and the Bill Williams River NWR had showed increases that correlated with the increase of parasitism that started in 2002 at these sites.

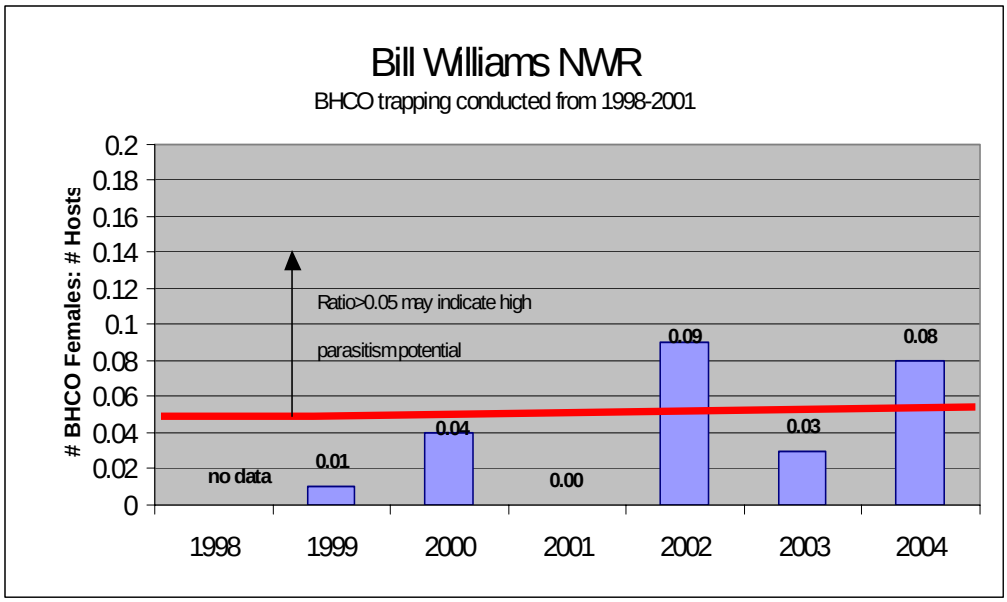
The ratios at Havasu NWR decreased starting in June 2003, but parasitism had continued to increase (Figure 12). The ratio had remained high from 1999 to 2002 at the Havasu NWR which correlates with the much higher parasitism in the WIFL population observed by McKernan and Braden (2002). The decrease in the host ratio during June of 2003 and 2004 at the Havasu NWR may correlate with the BHCO control that started in June 2003. The 34 percent parasitism rate observed in WIFL nests in 2004 at Havasu NWR is the highest since 1999 and may be a result of a small sample size of WIFL nests (n=10), a larger population of BHCOs, or may be independent of BHCO control during the first two seasons of control efforts.

BHCO Parasitism

It appears that parasitism rates for the four host species, including WIFLs, have increased within our nest monitoring plots during 3 years after termination of BHCO trapping. The increasing 2002-2004 parasitism rates of 5 percent to 21 percent for four host species exceeded rates observed during the 1999-2001 trapping years at Alamo Lake (Figure 13). It is not clear if the increase in parasitism is attributable to cessation of trapping. Parasitism rates of WIFL nests at Havasu have experienced a concurrent similar trend with an entirely different BHCO trapping scenario. Here, limited trapping was conducted in 1998 (White et al. 1998), with more extensive trapping in 2004 and 2004 (SWCA 2004).

It has been estimated that parasitism rates greater than 25 percent could threaten the long-term survival of certain localized populations of host species (Smith 1999). Only 1 of the 26 WIFL nests found at Alamo Lake and Bill Williams sites were parasitized following cessation of trapping. During the 1999-2001 BHCO control program, parasitism rates for host species ranged





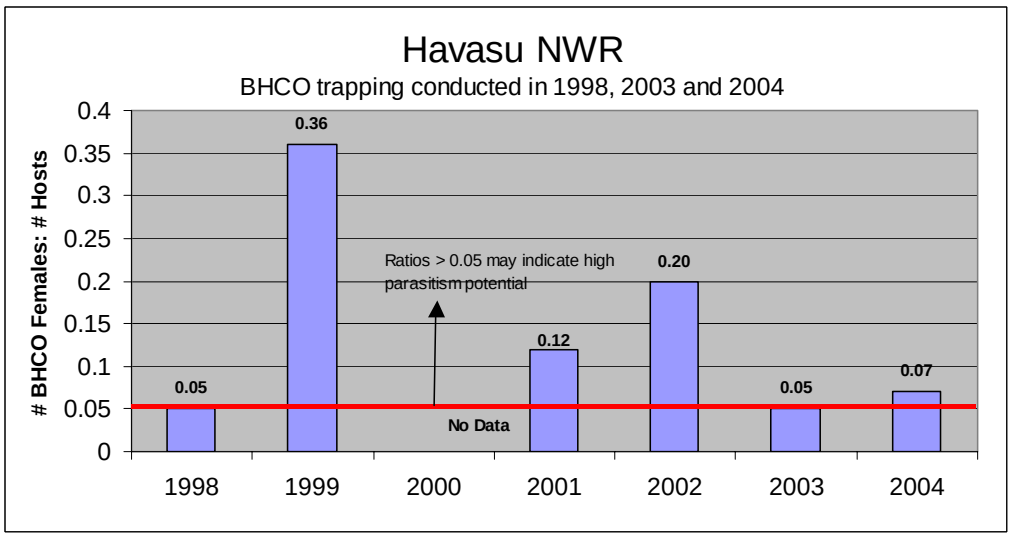


Figure 12. Ratio of numbers of BHCO females to host species detected during point counts – 1998-2003.

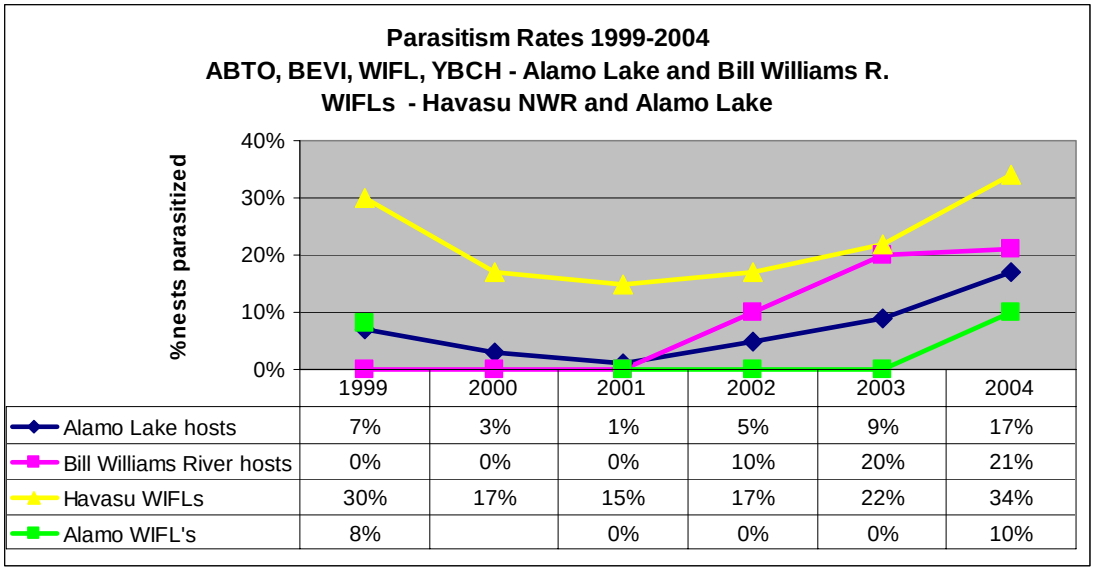


Figure 13. Parasitism observed in nest monitoring plots from 1999 to 2003.
(Havasu data from McKernan and Braden 2002, SWCA 2004, and Olson pers. com. 2004).

from zero to 5 percent and from zero to 8 percent for WIFLs. Only 1 of the 29 WIFL nests monitored was parasitized during the trapping years at Alamo Lake, and that occurred during the first trapping year.

Unfortunately, no pre-trapping parasitism data are available specifically for our study plots at the Alamo Lake SWA or Bill Williams River NWR. However, during the 1997 to 1998 trapping seasons in Bill Williams River NWR, parasitism rates ranged from 11 percent to 27 percent for BEVI and zero to 12 percent for YBCH in other nearby plots (Morrison and Averill-Murray 2002). Parasitism rates for WIFL nests at Havasu NWR ranged from 15 percent to 30 percent from 1998-2001 (McKernan and Braden 2002). Averill (1996) found parasitism rates in the Lower Colorado River Valley ranged from 40 percent to 90 percent for three same common host species during 1994-1995; the Bill Williams River NWR was included in her study area. If parasitism rates were in that range prior to start of our trapping, we conclude that trapping may have reduced parasitism during the trapping years extending into the third year after the cessation of trapping. However, previous agricultural practices may have contributed to the higher BHCO abundance and parasitism rates of the past. We also suspect that BHCO numbers and parasitism levels may continue to increase, especially at Alamo Lake SWA. Future monitoring could confirm this and further evaluate the effectiveness of and need for BHCO control.

The decreasing trend in nest success from 82 percent to 64 percent for four common host species in Alamo Lake SWA is the result of both increasing parasitism and nest predation. Combined predation rates of BEVI, YBCH, and WIFL nests increased from 10 percent in 2001 to 24 percent in 2004. However, predation rate for WIFLs was 30 percent in both 2001 and 2004 and ranged from 25 percent in 2002 to 33 percent in 2003. Unfortunately, there has been a reduction of the number of WIFL nests at Alamo Lake from 24 nests in 2001 to 10 in 2004 with similar monitoring efforts (Figure 14). The assumed reduced number of WIFL nesting pairs

may be a result of the drought, reduced flows into Alamo Lake, reduced flooding and soil moisture in the breeding habitat, and increasing distance between the habitat and Alamo Lake pool.

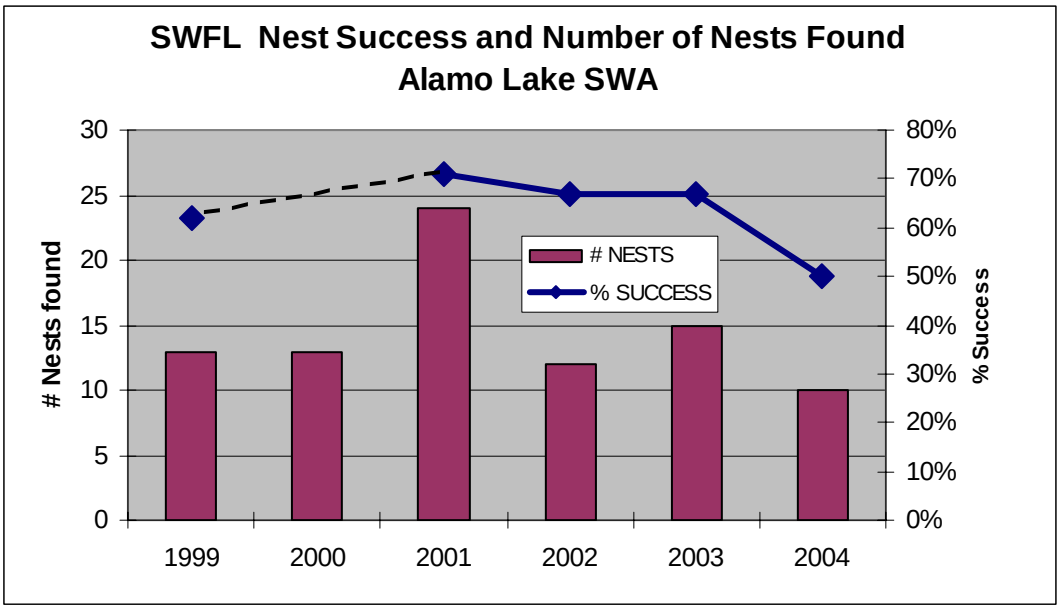


Figure 14. Relation of WIFL nesting success and number of nests at Alamo Lake from 1999 to 2004.

Although parasitism rates were low at our study areas, the 2003 nest success ranged from 65 percent to 87 percent for all species at Alamo Lake and Bill Williams NWR, respectively (66 percent to 100 percent for WIFLs). For comparison, nest success of WIFLs at Havasu NWR ranged from 25 percent to 78 percent (average = 47 percent) from 1997 to 2001 (McKernan and Braden 2002). Nest success for several host species ranged from 38 percent to 63 percent along the Rio Grande in New Mexico in 2001 (Bureau of Reclamation 2001).

Conclusions and Recommendations

Our study at the Alamo Lake SWA and Bill Williams River NWR indicates that following cessation of trapping in 2001, there has been an increase in BHCO abundance, BHCO to host ratios, and parasitism rates along with decreasing nesting success and number of WIFL nesting territories. Throughout the study, parasitism rates remained relatively low and below effect levels for WIFLs. However, there should be some concern if the post-trapping trends continue. Therefore, we recommend that nest monitoring should continue during the 2005 breeding season, especially for WIFLs at Alamo Lake SWA, where there is a viable but declining WIFL breeding population.

Any future BHCO control programs at new sites should be preceded by pre-trapping baseline studies, including study designs that would determine the effectiveness of trapping on the long-term reproductive success and population trends of the WIFL and other host species (Siegle and Ahlers, 2004).

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APPENDIX